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Gehyra koira sp. nov. (Reptilia: Gekkonidae), a new species of lizard with two allopatric subspecies from the Ord-Victoria region of north-western Australia and a key to the *Gehyra australis* species complex

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ABSTRACT

A new species of *Gehyra* Gray, 1834 (Reptilia: Gekkonidae) with two allopatric subspecies, *G. koira koira* ssp. nov. and *G. koira ipsa* ssp. nov., is described. A member of the *G. australis* species complex, *G. koira* sp. nov. is distinguished from congeners by a combination of morphometric and meristic characteristics. The two subspecies are allopatric in distribution and show morphological differentiation. The species is saxicoline and occurs on sandstone ranges and outliers in the Ord-Victoria region of north-western Australia. A key is provided to members of the *G. australis* species complex.

Keywords: Reptilia, Gekkonidae, *Gehyra*, new species, new subspecies, allopatric, north-western Australia.

INTRODUCTION

The genus *Gehyra* Gray, 1834, is a speciose taxon of gekkonid lizard found in Australia, Madagascar, Asia, the Indo-Malayan Archipelago, New Guinea and Pacific Islands. One taxon, *G. mutilata* (Wiegmann, 1834), has been introduced to Mexico, southern California, and recently to French Guyana (Ineich and de Massary 1997). *Gehyra* comprises about 33 species (Uetz *et al.* 2005).

Eighteen *Gehyra* species are currently recognised from Australia (Stanger *et al.* 1998; Cogger 2000; Wilson and Swan 2003; Uetz *et al.* 2005): *G. australis* Gray, 1845; *G. baliola* (Duméril and Duméril, 1851); *G. borroloola* King, 1983a; *G. catenata*, Low, 1979; *G. dubia* Macleay, 1877; *G. minuta* King, 1982; *G. montium* Storr, 1982; *G. mutilata*; *G. nana* Storr, 1978; *G. occidentalis* King, 1984; *G. oceanica* (Lesson, 1830); *G. pamela* King, 1982; *G. pilbara* Mitchell, 1965; *G. punctata* (Fry, 1914); *G. purpurasceus* Storr, 1982; *G. robusta* King, 1983a; *G. variegata* (Duméril and Bibron, 1836) and *G. xenopus* Storr, 1978. Of these, *G. baliola* and *G. mutilata* are peripheral components of the Australian fauna. *Gehyra mutilata* has been found on two offshore Territories (Cocos (Keeling) and Christmas Islands) (Cogger 2000), while *G. baliola* is essentially New Guinean but is also known from Darnley and Murray Islands in northern Torres Strait (King *et al.* 1989). The occurrence of *G. oceanica* is based on suspect records from islands of Torres Strait (Cogger 2000) and, following King *et al.* (1989), *G. oceanica* is not treated as part of the Australian fauna. A further taxon, *G. fenestra* Mitchell, 1965, is occasionally listed as a valid Australian species (Cogger *et al.* 1983; Uetz *et al.* 2005), even though that name has been placed in the synonymy of *G. punctata* (Storr 1982; Storr *et al.* 1990).

In Australia, *Gehyra* species are arboreal or saxicoline, are found through a diverse array of habitats ranging from arid deserts to tropical woodland, and often frequent human dwellings. Many species exhibit a high degree of habitat specificity and may have restricted distributions (Wilson and Swan 2003).

Examination of specimens collected during herpetological surveys in north-western Northern Territory identified a series of unusual *Gehyra* from rocky habitats. These were recognised as being conspecific with specimens recorded by Gambold (1992) who, in a survey of the fauna of Purnululu (Bungle Bungle) National Park, considered his specimens to represent an undescribed species of *Gehyra*.

The specimens share many features with *G. australis* and would be referred to that species in most identification keys. This paper describes the new species and distinguishes two subspecies on distribution and morphological grounds. A comparison is made with those species with which it could be confused and some features of its habitat are described.

METHODS

A detailed morphometric and meristic analysis was made of 58 specimens of the previously undescribed species of *Gehyra*. The characters quantified for each specimen are listed in Table 1. Measurements were made with electronic digital calipers and a steel rule. Counts of labial scales and subdigital lamellae were made on only one side of the body, tails were visually assessed and only distinctly original tails were measured. The colouration and body pattern of each specimen was also recorded. Nomenclature for scalation follows that of King (1983a). Of the measurements and counts taken, the following require individual definition:

1. Body length: measured between axilla and groin;
2. Tail length: measured from posterior edge of vent to tip of tail;
3. Limb lengths: measured from body wall to tip of longest digit;
4. Forebody length: measured from axilla to tip of snout;
5. Midbody scale rows: counted around midpoint of body;
6. Internasal scales: count of scales between nasals and contacting rostral;
7. Labial scales: count of obviously distinct scales between rostral (supralabials) or mental (infralabials) and jaw articulation.

A series of 34 specimens of *G. australis* were also examined for comparison. These were sourced from the vicinity of that taxon's type locality (Port Essington, Northern Territory) as well as other northern localities, including the Ord-Victoria region (see Appendix).

Data were recorded from mature specimens only, however, to minimise variation due to body size, all morphological variables were adjusted using the standard allometric growth formula, $\log(y) = a \log(x)+b$, where y is the allometric dependent variable and x is the independent variable (Sokal and Rohlf 1969). Morphometric character values were adjusted to what they would be if the specimens were of mean body size by applying the formula $\underline{Y}_i = \log Y_i - b(\log X_i - \log \underline{X})$, where $\underline{Y}_i$ is the natural logarithm of the value for the adjusted dependent variable of the ith specimen; Y_i is the value for the unadjusted dependent variable of the ith specimen; b is the pooled regression coefficient of $\log Y$ against $\log X$; X_i is the value for the independent variable of the ith specimen; and, $\underline{X}$ is the value for the grand mean of the independent variable (Thorpe 1975; Shea 1995). The resulting logarithm value of the dependent variable was transformed to its adjusted value by calculation of the antilog. Allometrically adjusted values were used in statistical analyses only.

Similarity between individuals was principally investigated by discriminant function analysis (DFA) using all characters showing non-sexually dimorphic variation. Comparisons between male and female specimens and between sexually dimorphic variables of the new species and *G. australis* were made using Mann-Whitney U-tests. Tests were carried out with the statistical program STATISTICA (Statsoft Inc. 1997). When available modal values are given and, where appropriate, asterisks indicate probability levels for significant differences between taxa as follows: *<0.01; **<0.005; ***<0.001.

The following abbreviations are used in the text: NTM, Museum and Art Gallery of the Northern Territory, Darwin; WAM, Western Australian Museum, Perth; SVL, snout-vent length.

RESULTS

Meristic and morphometric characters for specimens of the new *Gehyra* species and *G. australis* are shown in Table 1. Pairwise tests of characters for sexual dimorphism revealed that males differ by possessing preanal pores and postanal tubercles and may also have larger heads and correspondingly longer postmental scales (see taxon descriptions).

Similarity of individuals was tested by discriminant function analysis of snout-vent length plus five meristic and six, allometrically adjusted, morphometric variables (fourth finger lamellae, interorbital, internasal, infralabial and mid-body scales, fore and hindlimbs, body and snout lengths, rostral and head widths) from 92 specimens. Results of the DFA (Fig. 1) segregated the individuals into three clusters in the ordination space. Distinguished in the ordination space by the first discriminant function, cluster 'A' (*G. australis*) was principally separated from clusters 'B' and 'C' (new *Gehyra* species) by the discriminating variables: snout-vent length, number of interorbital scales, hindlimb length, number of infralabial scales, number of fourth finger subdigital lamellae and head width (standardised coefficients for canonical variables = 0.88, 0.56, 0.43, 0.36, 0.33 and −0.30). Clusters 'B' and 'C' were distinguished in the ordination space by the second discriminant function, with principal discriminating variables being: head width, number of interorbital scales, forelimb length, snout-vent length, number of mid-body scale rows and snout length (standardised coefficients for canonical variables = 0.74, -0.51, -0.43, -0.42, 0.35,

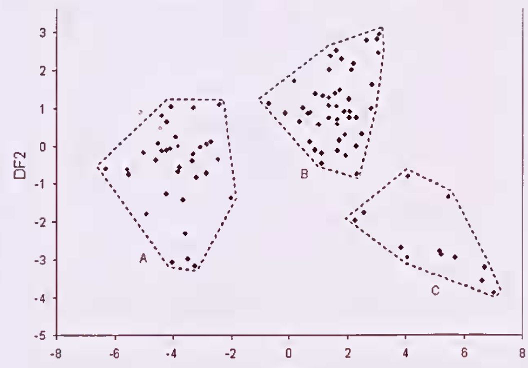

Fig. 1. Scatterplot resulting from discriminant function analysis of 11 non-sexually dimorphic variables from 92 specimens assigned to *Gehyra koira* sp. nov. and *G. australis*. Hand drawn polygons delineate clusters of morphologically similar individuals. Legend for clusters: A = *G. australis;* B = *G. k. koira* ssp. nov.; C = *G. k. ipsa* ssp. nov.

Table 1. Summary of morphometric and meristic variables for *Gehyra koira* sp. nov., its two subspecies and *G. australis* for comparison. Presented are means (± 1 SD) and ranges in parentheses. Probability associated with Mann-Whitney U-test between the two subspecies and between *G. koira* sp. nov. and *G. australis* is given for each variable. 'ns' indicates P>0.1.

Characteristics	***Gehyra koira koira* ssp. nov.** n = 46 (29 males)	***Gehyra koira ipsa* ssp. nov.** n = 12 (6 males)	**Prob.** (*Z*)	***Gehyra koira* (all specimens)** n = 58 (35 males)	***Gehyra australis*** n = 34 (12 males)	**Prob.** (*Z*)
No. of interorbital scales	41.8 ± 2.97 (35-47)	45.8 ± 2.6 (42-50)	3.69***	42.6 ± 3.3 (35-50)	33.6 ± 3.0 (28-42)	-7.74***
No. of internasal scales	2.4 ± 0.5 (2-3)	2.8 ± 0.4 (2-3)	2.22*	2.5 ± 0.5 (2-3)	2.8 ± 0.4 (2-3)	2.34*
No. of supralabial scales	10.2 ± 0.8 (8-12)	10.1 ± 1.1 (8-12)	ns	10.2 ± 0.9 (8-12)	9.1 ± 0.5 (8-10)	-5.63***
No. of infralabial scales	9.1 ± 0.7 (8-11)	9.2 ± 0.7 (8-10)	ns	9.1 ± 0.7 (8-11)	7.8 ± 0.6 (7-9)	-6.30***
No. of midbody scale rows	141.1 ± 9.1 (122-159)	136.6 ± 8.0 (122-150)	ns	140.2 ± 9.0 (122-159)	123.3 ± 7.7 (108-143)	-6.72***
No. of 4th toe lamellae	12.2 ± 0.7 (10-14)	12.4 ± 0.8 (11-13)	ns	12.2 ± 0.7 (10-14)	10.6 ± 0.7 (9-12)	-6.98***
No. of 4th finger lamellae	10.7 ± 0.7 (9-12)	10.7 ± 0.5 (10-11)	ns	10.7 ± 0.7 (9-12)	9.0 ± 0.7 (8-10)	-7.27***
No. of preanal pores	14.7 ± 1.5 (12-18)	16.7 ± 1.7 (15-20)	2.27*	15.1 ± 1.7 (12-20)	12.8 ± 3.3 (10-20)	-3.13**
No. of postanal tubercles	2.6 ± 0.5 (2-4)	2.2 ± 0.4 (2-3)	ns	2.5 ± 0.5 (2-4)	2.1 ± 0.6 (1-3)	-2.07*
Snout-vent length (SVL)	74.6 ± 4.0 (65-86)	85.2 ± 9.5 (66-96)	3.52***	76.8 ± 7.0 (65-96)	63.2 ± 5.2 (54-74)	-7.37***
Percentages (of SVL)						
Body length	47.6 ± 2.3 (41.5-52.9)	45.1 ± 3.7 (37.3-49.3)	-2.13*	47.1 ± 2.9 (37.3-52.9)	47.9 ± 2.5 (43.3-52.7)	ns
Tail length	105.9 ± 7.0 (96.1-118.7)(n=16)	99.2 ± 10.4 (92.4-111.2)(n=3)	ns	104.8 ± 7.7 (92.4-118.7)(n= 19)	102.7 ± 8.7 (87.5-115.5)(n=8)	ns
Forelimb length	30.2 ± 1.5 (27.3-33.9)	31.8 ± 2.2 (28.6-36.0)	2.04*	30.5 ± 1.7 (27.3-36.0)	29.0 ± 1.7 (24.8-33.0)	-3.55***
Hindlimb length	37.3 ± 2.6 (33.3-43.6)	39.1 ± 3.6 (35.6-45.1)	ns	37.7 ± 2.9 (33.3-45.1)	35.2 ± 2.4 (30.8-42.1)	-4.03***
Forebody length	44.1 ± 1.7 (41.0-48.2)	42.8 ± 2.0 (39.7-45.8)	ns	43.8 ± 1.8 (39.7-48.2)	43.1 ± 2.1 (38.9-47.5)	ns
Postmental length	4.1 ± 0.3 (2.7-4.7)	3.4 ± 0.4 (2.8-4.1)	-4.53***	3.9 ± 0.4 (2.7-4.7)	4.1 ± 0.4 (3.8-5.2)	ns
Head length	23.5 ± 0.6 (22.2-24.7)	22.7 ± 1.0 (20.8-24.4)	-2.65**	23.3 ± 0.7 (20.8-24.7)	23.0 ± 1.0 (20.4-25.2)	ns
Snout length	10.2 ± 0.4 (9.4-11.1)	10.0 ± 0.4 (9.1-10.6)	ns	10.2 ± 0.4 (9.1-11.1)	10.1 ± 0.6 (9.1-11.9)	ns
Ratios						
Head length : head height	2.1 ± 0.1 (1.9-2.3)	2.2 ± 0.1 (2.1-2.4)	2.86**	2.1 ± 0.1 (1.9-2.4)	2.0 ± 0.1 (1.7-2.4)	-3.61***
Head width : head height	1.7 ± 0.1 (1.4-2.0)	1.7 ± 0.1 (1.6-1.8)	ns	1.7 ± 0.1 (1.4-2.0)	1.6 ± 0.1 (1.4-1.9)	-4.33***
SVL : postmental length	24.6 ± 2.6 (21.3-37.4)	29.9 ± 3.2 (24.4-35.2)	4.53***	25.7 ± 3.5 (21.3-37.4)	24.5 ± 2.2 (19.0-28.0)	ns
SVL : snout length	9.8 ± 0.4 (9.0-10.6)	10.0 ± 0.4 (9.4-11.0)	ns	9.8 ± 0.4 (9.0-11.0)	9.9 ± 0.6 (8.4-10.9)	ns
Body length: hindlimb length	1.3 ± 0.1 (1.1-1.5)	1.2 ± 0.1 (1.0-1.3)	-2.17*	1.3 ± 0.1 (1.0-1.5)	1.4 ± 0.1 (1.1-1.6)	3.98***
Body length : head length	2.0 ± 0.1 (1.7-2.3)	2.0 ± 0.1 (1.8-2.2)	ns	2.0 ± 0.1 (1.7-2.3)	2.1 ± 0.2 (1.7-2.4)	2.03*

-0.32). Thus, the DFA recognised three morphotypes from the individuals examined, not only supporting the specific differentiation of the new *Gehyra* species from *G. australis* but also identifying two groups among the individuals allocated to the new taxon.

Investigation of individuals in clusters 'B' and 'C' revealed that those enclosed within cluster 'C' were collected from Purnululu (Bungle Bungle) National Park, while those in cluster 'B' were representative of several localities to the north, east and south of that locality (see Fig. 2). Further investigation into differentiation of the Purnululu population was carried out by pairwise comparison of variables not used in the discriminant function analysis. These tests revealed additional differences in two meristic and three morphometric variables (numbers of internasal scales and preanal pores, body length (% 0f SVL), SVL to postmental length and body length to hindlimb length) (Table 1).

Morphological differentiation between the Purnululu population ('C') and the 'B' populations is not considered sufficient to warrant their description as separate species. However, on the grounds of detectable morphological differentiation and apparent allopatric distributions, they are assigned to subspecies.

SYSTEMATICS

Employing the generic diagnosis provided by King and Horner (1989) the new taxon is assigned to the gekkonid genus *Gehyra*. The description of the new species is based upon meristic and morphometric data given in the following descriptions of two subspecies. In combination, all specimens representing the new species conform to the following diagnosis.

Gehyra Gray, 1834

Gehyra koira sp. nov.

Diagnosis. A large, robust, dorsoventrally depressed, saxicoline gecko, *G. koira* sp. nov. is distinguished from Australian congeners by large adult size (mean snout-vent length = 76.8, range 65–96 mm) and the following combination of characters. Rostral scale oblong in shape, no prominent skin folds on hindlimbs, undivided smooth-edged subdigital lamellae under the dilated section of the fourth toe and mean values of: 140 midbody scale rows; 43 (mode = 41) interorbital scales; 10 (mode = 10) supralabial scales; 12 (mode = 12) subdigital lamellae under the dilated section of the fourth toe; 15 (mode = 16) preanal pores in male; and a transversely aligned dorsal body pattern dominated by irregular, narrow pale bars.

Comparison with similar species. *Gehyra koira* sp. nov. is distinguished from most Australian congeners by attaining a larger size (maximum SVL: 96 versus <80 mm). *Gehyra baliola* exceeds *G. koira* sp. nov. in size, but is distinguished by having a characteristic U-shaped rostral scale and posterior skin folds on each hindlimb.

Gehyra koira sp. nov. is further distinguished from *G. borroloola, G. minuta, G. montium, G. mutilata, G. nana, G. occidentalis, G. pilbara, G. punctata, G. purpurascens, G. variegata* and *G. xenopus* by having entire rather than medially divided subdigital lamellae on the dilated section of the fourth toe. Of the remaining Australian *Gehyra, G. pamela* has heavily notched or medially divided subdigital lamellae on the dilated section of the fourth toe, fewer midbody scale rows (mean: 119.0 versus 140.2) and more preanal pores in males (mean: 23.2 versus 15.1). *Gehyra dubia* has deeply notched subdigital lamellae on the dilated section of the fourth toe, and fewer interorbital scales (<37 versus a mean of 42.6). *Gehyra robusta* has medially depressed subdigital lamellae on the dilated section of the fourth toe, fewer fourth toe lamellae (mean: 10.3 versus 12.2) and interorbital scales (mean: 26.2 versus 42.6). *Gehyra catenata* has fewer subdigital lamellae on the dilated section of the fourth toe (7–8 vs 10–14) and a dark zigzag-like dorsal pattern. *Gehyra australis* has fewer interorbital scales (mean: 33.6 versus 42.6), midbody scale rows (mean: 123.3 versus 140.2) and preanal pores in males (mean: 12.8 versus 15.1) (see Table 1).

Distribution and habitat. The known distribution of *G. koira* sp. nov. is the Ord-Victoria region of north-western Australia (Fig. 2). This distribution extends from the east Kimberley region of Western Australia in the vicinity of Kununurra and Purnululu (Bungle Bungle) National Park, south-eastwards to the vicinity of Top Springs in the Northern Territory, and south to the Gardner Range in the northern Tanami Desert.

The species is saxicoline and occurs on ranges and their outliers, where it exhibits a preference for larger massifs. It is commonly encountered in caves and on rock faces.

Subspecies. *Gehyra koira* sp. nov. is a polytypic taxon comprised of two allopatric subspecies.

Gehyra koira koira ssp. nov.

(Figs 1, 3–6)

Material examined. HOLOTYPE – NTM R.22406, adult female, Nganlang Art Site, Keep River National Park, Northern Territory, 15°48'26"S 129°06'23"E, coll. P. Horner, 27 April 1996. PARATYPES (45 specimens). NORTHERN TERRITORY: NTM R.9125-127, 9130, 9132, Keep River National Park, 15°51'S 129°02'E, coll. Fauna Survey team, September 1980; NTM R.10079, 10518-522, 10524-526, Keep River National Park, 15°51'S 129°02'E, coll. Fauna Survey team, April 1982; NTM R.18626-628, Bradshaw Station, 15°19'56"S 130°06'08"E, coll. A. Fisher, 7 June 1997; NTM R.20774-775, Timber Creek, 15°41'S 130°28'E, coll. N. Gambold, 2 May 1990; NTM R.12770, Jasper Gorge, Buchanan Hwy, 16°01'S 130°45'E, coll. P. Horner, 11 November 1984; NTM R.25499, Jasper Gorge, Buchanan Hwy, 16°01'49"S 130°47'55"E, coll. K. Nash, 17 November 1999; NTM R.23800, 23804, Wickham River,

Fig. 2. Map of northwestern Australia showing known distribution of *Gehyra koira* sp. nov. Legend: circles = *G. k. koira* ssp. nov.; triangles = *G. k. ipsa* ssp. nov.

Gregory National Park, 16°50'54"S 130°14'16"E, coll. P. Horner, 4 June 1998; NTM R.23875, Wickham River, Gregory National Park, 16°03'03"S 130°24'05"E, coll. D. Milne, 17 February 1998; NTM R.9471, Victoria River Bridge area, Victoria Hwy, 15°37'S 131°05'E, coll. G. Armstrong, 18 October 1980; NTM R.13265, Victoria River Bridge area, Victoria Hwy, 15°37'S 131°05'E, coll. P. Edgar, 27 May 1986; NTM R.23754-755, Lonely Springs Creek Crossing, Buntine Highway, 16°42'14"S 131°41'56"E, coll. P. Horner, 30 May 1998; NTM R.22404, Jarrnarm Escarpment, Keep River National Park, 15°46'05"S 129°05'24"E, coll. P. Horner, 24 April 1996; NTM R.22462, Limestone Gorge, Gregory National Park, 16°03'01"S 130°24'18"E, coll. K. Claymore, 14 April 1996; NTM R.22910, Spirit Hills, 15°28'S 129°13'E, coll. Ecologia Environmental Consultants, 11 October 1996; NTM R.24623, Augustus Hole, Spirit Hills Station, 15°23'38"S 129°11'10"E, coll. H. Larson, 10 October 1998; NTM R.24103, North Kollendong Valley, Bradshaw Station, 15°00'26"S 130°03'12"E, coll. P. Horner, A. Hertog, L. Corbett, R. Batterham, 4 November 1998; NTM R.24251-255, Fitzmaurice River, Bradshaw Station, 15°06'37"S 130°19'37"E, coll. P. Horner, A. Hertog, L. Corbett, R. Batterham, 8 November 1998; NTM R.24850, 24853, Lobby Creek, Bradshaw Station, 15°19'48"S 130°06'15"E, coll. P. Horner, A. Hertog, L. Corbett, R. Batterham, 3 September 1999; NTM R.27279, Pigeon Hole, Gregory National Park, 15°24'S 131°22'E, coll. M. Armstrong, 14 May 2003; NTM R.23365, Jellabra Rockhole, Tanami Desert, 19°21'40"S 129°00'38"E, coll. D. Gibson, 7 June 1996. WESTERN AUSTRALIA: NTM R.7043, Kununurra, 15°47'S 12.44'E, coll. S. Swanson, May 1979; NTM R.7113-114, Kununurra, 15°47'S 12.44'E, coll. G. Gow, 7 June 1979.

Diagnosis. As given above for species. Distinguished from conspecific 'C' population (Fig. 1) by having fewer interorbital scales (mean = 41.8 versus 45.8, $Z = 3.69^{***}$) and preanal pores in males (mean = 14.7 versus 16.7, $Z = 2.27^{*}$), a longer body (mean % of snout-vent length = 47.6 versus 45.1, $Z = -2.13^{*}$), shorter forelimb (mean % of snout-vent length = 30.2 versus 31.8, $Z = 2.04^{*}$) and by being smaller (mean snout-vent length = 74.6 versus 85.2, $Z = 3.52^{***}$).

Description. *Head.* Large and slightly compressed (Fig. 3): width 74.3–87.6% (mean = 82.3%) of head length; height 42.6–52.0% (mean = 47.2%) of head length; length 22.2–24.7% (mean = 23.4%) of snout-vent length; snout 40.3–46.6% (mean = 43.5%) of head length. Head covered in small granular scales. 35–47 (mean = 41.8, mode = 41) interorbital scales. Nostril surrounded by rostral, internasal, two posterior nasal and first supralabial scales. Rostral scale oblong, usually with a median, vertical groove in upper half. Rostral relatively deep, 1.5–2.1 (mean = 1.8) times wider than high, with a horizontal or slightly gabled dorsal margin. Nostrils usually separated by two large internasal scales (59% of specimens); a smaller middle internasal often present. 8–12 (mean = 10.2, mode = 10) supralabial and 8–11 (mean = 9.1, mode = 9) infralabial scales. Mental scale roughly triangular. Postmental scales usually four, larger median pair relatively long (2.7–4.7% (mean = 4.1%) of snout-vent length; 1.5–2.6 (mean = 1.9) times longer than wide) and in contact with first infralabial. Outer postmentals in contact with first and second supralabials.

Body. Dorso-ventrally compressed, heavily built (Fig. 4). Snout-vent length to 86.0 mm (mean = 74.6 mm). Dorsal surface covered by small non-imbricate rounded scales. Imbricate scales on ventral surface larger and flatter than those on dorsum. Body length 41.5–52.9% (mean = 47.6%) of snout-vent length. Tail (original) ovoid to round in section, 96.1–118.7% (mean = 105.9%) of snout-vent length. Single transverse subcaudal scales. 122–159 (mean = 141.2) scales around circumference of abdomen in midbody. Single indistinct lateral skin fold usually present on each side of lower body. No skin folds on limbs. Forebody 40.9–48.2% (mean = 44.1%) of snout-vent length. 10–14 (mean = 12.2, mode = 12) subdigital lamellae on dilated section of fourth toe, 9–12 (mean = 10.8, mode = 11) on dilated section of fourth finger. Subdigital lamellae usually even and undivided, occasional slight median depression or notch may be present (Fig. 5). No pronounced webbing between toes. Hindlimbs larger than forelimbs. Forelimb 27.3–33.9% (mean = 30.2%) of snout-vent length. Hindlimb 33.3–43.6% (mean = 37.3%) of snout-vent length. Male specimens have 12–18 (mean = 14.8) preanal pores in a broad V-shape (anterior apex), and 2–4 (mean = 2.6, mode = 3) postanal tubercles in bi-lateral clusters at base of tail.

Variation in meristic and morphometric variables is summarised in Table 1.

Colour and pattern. *In ethanol.* Dorsal ground colour of body and appendages pale brown-grey. Five to eight narrow pale bars, with broader brown anterior margins, irregularly transversing dorsal body surface. These narrow bars usually represented by three or four transverse pale streaks, that may be contiguous or slightly off-set from each other. Bars extend onto tail where they form indistinct, regular cross-bars. Occasional irregular, pale spots usually present on body. Limbs obscurely patterned with small, pale blotches. Head patterned with some indication of narrow, dark loreal and temporal stripes. Ventral surfaces of body and appendages creamish.

In life. Dorsal ground colour of body and limbs light brown. Pale, dorsal bars anteriorly margined with broader blackish-brown extended blotches. Dark margins about twice width of pale bars. Lateral surfaces of body patterned with occasional, small pale blotches. Tail concolorous with dorsum, except that dark anterior margins intrude into pale bars at midline. Limbs patterned with obscure, small pale blotches and dark flecks. Head yellowish-brown, with postorbital pattern of scattered pale and dark blotches. Loreals and upper margins of supralabials speckled with dark brown. Narrow, blackish-brown temporal stripe extending from mid-posterior margin of orbit to above ear.

Living specimens may lose this colouration dramatically; fading till the dorsal surface becomes light grey with faint darker areas. The ventral surface remains cream-coloured.

Sex ratio and sexual dimorphism. The sex ratio of specimens examined favoured males (29:17). All meristic and morphometric variables were tested for sexual dimorphism, with significant differences being found for head depth (% of head length – males: mean = 47.8, sd = 2.88; females: mean = 46.1, sd = 2.07; $Z = -1.99^{*}$), postmental length (% of SVL, males: mean = 4.2, sd = 0.20; females: mean = 4.0, sd = 0.48; $Z = -2.07^{*}$), forebody length (% of SVL – males: mean = 44.5, sd = 1.59; females: mean = 43.3, sd = 1.62; $Z = -2.06^{*}$) and the presence of preanal pores and postanal tubercles in males.

Details of holotype. (NTM R.22406, Fig. 6). Adult female. Snout-vent length 75.4 mm; body length 34.6 mm; tail length (original) 74.8 mm; forelimb length 24.3 mm; hindlimb length 25.6 mm; forebody length 33.1 mm; head length 17.3 mm; head depth 8.3 mm; head width 14.5 mm; snout length 7.5 mm; postmental scale length 2.9 mm; midbody scale rows 130; interorbital scales 39; internasal scales 3; supralabial scales 10; infralabial scales 10; fourth toe subdigital lamellae 12; fourth finger subdigital lamellae 11.

Fig. 3. Head of *Gehyra koira koira* ssp. nov. in life – Jarrnarm Escarpment, Keep River National Park, Northern Territory, 15°46'05"S 129°05'24"E.

Fig. 4. *Gehyra koira koira* ssp. nov. in life – Jarrnarm Escarpment, Keep River National Park, Northern Territory, 15°46'05"S 129°05'24"E.

Fig. 5. Ventral view of hindfoot of *Gehyra koira koira* ssp. nov. (NTM R.22910, Spirit Hills, Northern Territory, 15°28'S 129°13'E), showing subdigital lamellae undivided, but occasional lamellae with a median depression or notch.

Fig. 6. Holotype of *Gehyra koira koira* ssp. nov. (NTM R.22406).

Body pattern transversely aligned, conforming to species description above.

Etymology. From the Greek noun *koira*, meaning king, ruler or commander, in reference to Max King, in recognition of his landmark work on the cytology and taxonomy of *Gehyra*. The name is intended as a noun in apposition.

Distribution and conservation status. The known distribution of *G. koira koira* ssp. nov. is the Ord-Victoria region of north-western Australia (Fig. 2). In that region it has been collected on the massifs and outliers of the Burt, Pinkerton, Newcastle, Stokes, Yambarran and Bynoe Ranges. An apparent disjunct population occurs south of the main centre of distribution at Jellabra Rockhole in the Gardner Range, northern Tanami Desert.

Using the quantitative ranking method adopted by Cogger *et al.* (1993) to assess conservation status, and conservatively extrapolating some variables from congeners, *G. koira koira* ssp. nov. is scored at 22. This score is within the range assigned to the 'Rare or insufficiently known' category.

Habitat. Most specimens were collected from weathered quartz sandstone ranges and outliers. Showing a preference for larger massifs, *G. koira koira* ssp. nov. is locally abundant (pers. obs.), often being encountered in caves and on rockfaces.

Gehyra koira ipsa ssp. nov.

(Figs 1, 7–10)

Material examined. HOLOTYPE – WAM R.101238, adult male, Piccaninny Massif, Purnululu (Bungle Bungle) National Park, Western Australia, 17°27'S 128°24'E, coll. N. Gambold, 25 August 1989.

PARATYPES (11 specimens). WESTERN AUSTRALIA (all collected by N. Gambold): WAM R.104285, 104290-291, Echidna Chasm, Purnululu (Bungle Bungle) National Park, 17°20'S 128°26'E, 10 December 1989; WAM R.104284, Frog Hole Gorge, Purnululu (Bungle Bungle) National Park, 17°20'S 128°25'E, 10 December 1989; WAM R.104283, Osmand Valley Station, 17°15'S 128°19'E, 26 November 1989; WAM R.104286, 104288, 104295, Piccaninny Gorge, Purnululu (Bungle Bungle) National Park, 17°27'S 128°26'E, 9 December 1989; WAM R.101237, 101239, Piccaninny Massif, Purnululu (Bungle Bungle) National Park, 17°27'S 128°24'E, 25 August 1989; WAM R.104289, Wulwuldji Spring, Purnululu (Bungle Bungle) Conservation Reserve, 17°15'S 128°19'E, November 1989.

Diagnosis. As given above for species. Distinguished from *G. koira koira* ssp. nov. by having more interorbital scales (mean = 45.8 versus 41.8, $Z = 3.69^{***}$) and preanal pores (mean = 16.7 versus 14.7, $Z = 2.27^{*}$), a shorter body (mean % of snout-vent length = 45.1 versus 47.6, $Z = -2.13^{*}$), longer forelimb (mean % of snout-vent length = 31.8 versus 30.2, $Z = 2.04^{*}$) and by being larger (mean snout-vent length = 85.2 versus 74.6, $Z = 3.52^{***}$).

Description. *Head.* Large and slightly compressed (Fig. 7): width 70.8–82.4% (mean = 76.1%) of head length; height 42.2–47.7% (mean = 44.6%) of head length; length 20.8–24.4% (mean = 22.7%) of snout-vent length; snout 43.4–45.0% (mean = 44.1%) of head length. Head covered in small granular scales. 42-50 (mean = 45.8) interorbital scales. Nostril surrounded by rostral, internasal, two posterior nasal and first supralabial scales. Rostral scale oblong, usually with median, vertical groove in upper half. Rostral relatively deep, 1.5–1.9 (mean = 1.7) times wider than high, with horizontal or slightly gabled dorsal margin. Nostrils usually separated by two large and one small internasal scales (83% of specimens), occasionally only two large internasals present (17% of specimens). 8–12 (mean = 10.1) supralabial and 8–10 (mean = 9.2, mode = 9) infralabial scales. Mental scale roughly triangular. Postmental scales usually four, larger median pair relatively long [2.8–4.1% (mean = 3.4%) of snout-vent length; 1.4–2.0 (mean = 1.6) times longer than wide] and in contact with first infralabial. Outer postmentals in contact with first and second supralabials.

Body. Dorso-ventrally compressed, heavily built (Fig. 8). Snout-vent length to 96.0 mm (mean = 85.2 mm). Dorsal surface covered by small non-imbricate rounded scales. Imbricate scales on ventral surface larger and flatter than those on dorsum. Body length 37.3–49.3% (mean = 45.1%) of snout-vent length. Tail (original) ovoid to round in section, 92.4–111.2% (mean = 99.2%) of snout-vent length. Single transverse subcaudal scales. 122–150 (mean = 136.6) scales around circumference of abdomen in midbody. Single indistinct lateral skin fold usually present on each side of lower body. No skin folds on limbs. Forebody 39.9–45.8% (mean = 42.8%) of snout-vent length. 11–13 (mean = 12.4, mode = 13) subdigital lamellae on dilated section of fourth toe, 10–11 (mean = 10.7, mode = 11) on dilated section of fourth finger. Subdigital lamellae usually even and undivided (Fig. 9), occasional slight median depression may be present. No pronounced webbing between toes. Hindlimbs larger than forelimbs. Forelimb 28.6–36.0% (mean = 31.8%) of snout-vent length. Hindlimb 35.6–45.0% (mean = 39.1%) of snout-vent length. Males have 15–20 (mean = 16.7, mode = 16) preanal pores in broad V-shape (anterior apex), and 2–3 (mean = 2.2, mode = 2) postanal tubercles in bilateral clusters at base of tail.

Variation in meristic and morphometric variables summarised in Table 1.

Colour and pattern. Very similar to that given for the nominate subspecies, except that areas of dark pigmentation may be more intense, particularly so on original tails (see Fig. 8).

Sex ratio and sexual dimorphism. The sex ratio of specimens examined was identical (6:6). All meristic and morphometric variables were tested for sexual dimorphism, with significant differences being found for postmental scale length (% of SVL, males: mean = 3.6, sd = 0.26, n = 6; females: mean = 3.1, sd = 0.32, n = 6; $Z = -2.081^*$), midbody scale rows (males: mean = 131.5, sd = 6.25, n = 6; females: mean = 141.7, sd = 6.22, n = 6; $Z = 2.241^*$) and the presence of preanal pores and postanal tubercles in males.

Details of holotype. (WAM R.101238, Fig. 10). Adult male. Snout-vent length 95.0 mm; body length 41.8 mm; tail length (not original) 91.0 mm; forelimb length 33.1 mm; hindlimb length 42.8 mm; forebody length 42.5 mm; head length 21.6 mm; head depth 10.3 mm; head width 17.8 mm; snout length 9.6 mm; postmental scale length 3.5 mm; midbody scale rows 127; interorbital scales 43; internasal scales 3; supralabial scales 9; infralabial scales 9; fourth toe subdigital lamellae 12; fourth finger subdigital lamellae 11.

Body pattern transversely aligned, conforming to species description above.

Etymology. The subspecific epithet is from the Latin word *ipsa*, meaning to make prominent one of two or more subjects, in reference to the morphological divergence of the Purnululu population from conspecific populations. The name is here intended as a noun in apposition.

Fig. 7. Head of paratype of *Gehyra koira ipsa* ssp. nov. in life – Piccaninny Gorge, Purnululu (Bungle Bungle) National Park, Western Australia, 17°27'S 128°26'E.

Fig. 8. Paratype of *Gehyra koira ipsa* ssp. nov. in life – Piccaninny Gorge, Purnululu (Bungle Bungle) National Park, Western Australia, 17°27'S 128°26'E.

Fig. 9. Ventral view of hindfoot of *Gehyra koira ipsa* ssp. nov. (Holotype, WAM R.101238, Piccaninny Massif, Purnululu National Park, Western Australia, 17°27'S 128°24'E), showing undivided subdigital lamellae.

Fig. 10. Holotype of *Gehyra koira ipsa* ssp. nov. (WAM R.101238).

Distribution and conservation status. The known distribution of *G. koira ipsa* ssp. nov. is centred on the Bungle Bungle Range of north-eastern Western Australia (Fig. 2). In this region it has been collected in Purnululu National Park at Piccaninny Massif, Piccaninny Gorge, Echidna Chasm, 'Frog Hole' Gorge and Cathedral Gorge and in the Purnululu Conservation Reserve at Wulwuldji Spring. Gambold (1992) also records it from Bull Creek in Purnululu National Park and Mount John in the Osmand Range.

Using the quantitative ranking method adopted by Cogger *et al.* (1993) to assess conservation status, and conservatively extrapolating some variables from congeners, *G. koira ipsa* ssp. nov. is scored at 24. This score is within the range assigned to the 'Rare or insufficiently known' category.

Habitat. *Gehyra koira ipsa* ssp. nov. occupies sandstone ranges and outliers where it shows a preference for deep cool gorges and caves (Gambold 1992). Gambold (1992) associates the taxon with a floristic group dominated by *Eucalyptus cliftoniana, Cajanus* sp. and *Plectrachne pungens*. This low woodland vegetation occurs on dissected sandstone slopes (Menkhorst and Cowie 1992).

DISCUSSION

The genus *Gehyra* is strongly represented in the Australian region (53% of described species), where the main centre of diversity is in the northern monsoonal tropics (10 species). In northern Australia many *Gehyra* species occur in sympatry, although these tend to show a strong fidelity to different topography and habitat types. For example, *G. koira* is locally abundant on sandstone ridges and outcrops at Keep River National Park and Bradshaw Station in the Northern Territory (pers. obs.), where *G. australis* is also common in the surrounding woodlands (NTM records, Keep River: R.10501, 10503, 10505, 10527, 22370; Bradshaw: R.24823, 24833, 24873). Gambold (1992) also notes that *G. australis*, while not found on the massif, was common and widespread in Purnululu National Park, with most specimens coming from beneath loose bark of eucalypts. The small saxicoline congener *G. nana* has also been recorded at each of these sites (NTM records; Gambold 1992).

Subspecies of *G. koira* are apparently allopatric and may be geographically isolated, as the Bungle Bungle and Osmand Ranges are separated from ranges occupied by conspecifics by the Ord River and associated cracking-clay (blacksoil) plains. Morphological differences between the subspecies are not considered to represent the end of a geographical cline as the ordering of specimens of *G. koira koira* in the ordination space (Fig. 1, cluster B) shows no relationship to geographic origin, with representatives of the Keep River (geographically nearest to *G. koira ipsa*) and Gardner Range populations randomly scattered throughout cluster 'B'. It remains for further biological survey to determine whether the distribution of *G. koira* also extends into the sandstone plateau of the central Kimberley region.

King (1984) grouped together *G. australis, G. baliola, G. borroloola, G. dubia, G. occidentalis, G. pamela, G. robusta* and *G. xenopus* as members of a species complex that, while being in the same lineage as the other Australian *Gehyra*, have evolved as an independent group (King 1982, 1983b). Named after the earliest described member, the *G. australis* species complex was morphologically distinguished by adult specimens having a snout-vent length of 50–91 mm and at least nine subdigital lamellae under the dilated area of the fourth toe (King 1984). Under those morphological criteria, *G. koira* is assigned to the *G. australis* species complex.

As an aid to distinguishing *G. koira* from similar Australian *Gehyra*, the following dichotomous key to Australian members of the *G. australis* species complex is presented.

Key to the *Gehyra australis* species complex

1a. Rostral scale oblong; no cutaneous fold along posterior edge of hindlimb 2

1b. Rostral scale 'U' shaped; prominent cutaneous fold along posterior edge of hindlimb .... *G. baliola*

2a. Subdigital lamellae on fourth toe usually divided or at least deeply grooved 3

2b. Subdigital lamellae on fourth toe usually undivided, but sometimes with a median depression or notch 6

3a. Basal subdigital lamellae divided, but each pair usually in medial contact; snout-vent length to 69 mm 4

3b. Basal pairs of subdigital lamellae medially separated by triangular series of granular scales; snout-vent length to 79 mm .... *G. xenopus*

4a. Postmental scale relatively long (mean = 3.3 mm or more); midbody scale rows relatively few (mean = 119 or fewer); 19 or more preanal pores in male (mean = 23) 5

4b. Postmental scale relatively short (mean = 3.0 mm); midbody scale rows relatively numerous (mean = 122); 15 or less preanal pores in males (mean = 13) .... *G. borroloola*

5a. Rostral scale oblong with more or less horizontal dorsal margin; viewed from below, rostral projects forward of snout line; usually only two large internasal scales (occasionally a small median internasal may be present) .... *G. pamela*

5b. Rostral scale relatively deep with strongly gabled dorsal margin; in ventral view, rostral does not project forward of snout line; usually one or two small median internasals separate the two large internasal scales .... *G. occidentalis*

6a. Medium in size (SVL to 75 mm); interorbital scales relatively few (mean = <34); midbody scale rows relatively few (mean = <126); usually 11 or less fourth toe subdigital lamellae 7

6b. Large in size (SVL to 96 mm); interorbital scales relatively numerous (mean = 43.1); midbody scale rows relatively numerous (mean = 141.1); usually 12 fourth toe subdigital lamellae .... *G. koira*

7a. Medium in size (SVL to 75 mm); usually 10 or 11 subdigital lamellae; midbody scale rows relatively numerous (mean = >123) 8

7b. Small in size (SVL to 68 mm); usually 9 subdigital lamellae; midbody scale rows relatively few (mean = 119) .... *G. dubia*

8a. Dorsal ground colour orange-brown, dorsum irregularly banded with narrow dark bars and pale spots; interorbital scales relatively few (mean = 26.2); subdigital lamellae with median depression; saxicoline .... *G. robusta*

8b. Dorsal ground colour grey or grey-brown, dorsum unpatterned or with indistinct, broad dark bars; interorbital scales relatively numerous (mean = 33.6); subdigital lamellae usually lack a median depression; arboreal.. *G. australis*

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APPENDIX

Comparative *Gehyra australis* specimens examined.

NORTHERN TERRITORY: NTM R.20910, 20952, 21022, 11°09'S, 132°10'E, Black Point, Cobourg Peninsula; NTM R.13528-530, 13596, 11°33'S, 132°55'E, Murgenella; NTM R.13586, 13594, 11°33'S, 132°56'E, Murgenella Settlement; NTM R.7659, 12°03'S, 131°17'E, Cape Hotham; NTM R.11418, 12°27'S, 132°25'E, Mummarlary Station; NTM R.20402, 12°33'S, 132°55'E, Jabiluka; NTM R.2237, 12°40'S, 132°53'E, Jabiru; NTM R.33071, 14°41'S, 131°34'E, Daly River; NTM R.6210, 14°11'S, 132°01'E, Edith River, near Stuart Hwy Crossing; NTM R.94, 9815-818, 13004, 13006-008, 14°24'S, 132°20'E, Katherine Gorge; NTM R.888-889, 14°28'S, 132°16'E, Katherine; NTM R.6211-212, 14°35'S, 132°28'E, Cutta Cutta Caves; NTM R.10501, 10503, 10505, 10527, 15°45'S, 129°05'E, Keep River National Park; NTM R.22370, 15.58'S, 129°02'E, Cockatoo Lagoon, Keep River National Park.

WESTERN AUSTRALIA: NTM R.9960, 15°28'S, 128°06'E, Wyndham.

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